the collenchyma being most numerous on the tangential walls. The markings of fibrovascular elements are of the common form in this type of plants. The arrangement of the protoplasmic body of the organ with reference to density and composition, bears a direct relation to the sensitiveness of any part of the organ. The protoplasm is most dense and richly granular in the epidermis and chlorophyllous cells of the concave surface near the tip. The density decreases as it passes back into the middle region where it is quite uniform throughout. The contents of the epidermal cells and collenchyma of this side take the stain most deeply as does the epidermis of the convex side, which, as well as the underlying tissue, is very similar over the entire surface.

It may be assumed in conclusion, that the concentration of the protoplasm in the epidermal layer has a direct connection with irritability, that the movements of the organs are due to changes in the chlorophyll layer and that the disposition of the xylem elements is favorable to rapid flexion and extension, and that the abundant supply of reserve food material is a provision for the rapid growth and fixation of the tendril upon coiling.

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EXPLANATION OF PLATE XIV.—Fig. 1. Half cross section of middle portion of tendril.—Fig. 2. Longitudinal section of convex side of same.—Fig. 3. Longitudinal section of concave side of same. *a*, *a'*, epidermis; *b*, *b'*, collenchyma; *c*, *c'*, chlorophyll parenchyma; *d*, bast; *e*, xylem; *f*, pith.—Fig. 4. Longitudinal section of tip of tendril showing cavity, *a*.—Fig. 5. Cavity of same seen from end.—Fig. 6. Longitudinal section through tip of mature tendril. *a*—*d*, same as in fig. 1; *e*, cavity; *f*, epithema.—Fig. 7. Diagram showing distribution of protoplasm in tip and part of middle region of tendril.

An apparatus for determining the periodicity of root pressure.

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(WITH PLATE XV.)

The study of the periodicity of root pressure has received much attention from physiological botanists and the results of quite extended researches have been published by Sachs, Hofmeister, Detmer and others. The work has been done with very crude apparatus consisting simply of a manometer

or a glass tube attached to the stem at its base by means of a rubber tube making with it a water-tight connection. The observations were recorded by marking upon the tube each hour to indicate the rise of water in the tube or by measuring it with a scale in the glass or on a strip of paper or wood behind it. The apparatus required frequent attention and was in no sense self-registering. The other methods used were modifications of these but in all cases frequent attention was required.

The following self-registering apparatus is suggested: The base of the apparatus is about 1 by 3 feet and is supported by legs about 3 inches high. About 10 inches from one end and in the center of the base is erected a standard about 2 feet high and 4 inches in width. On the short end of the base and near the post is fastened a set of strong clock-work (the Seth Thomas "marine works" answer the purpose very well). The clock-work is covered with a box, and the end of a cylinder 6 inches in diameter and 1 foot 10 inches high is fastened to the hour pinion by means of a pin passing through a hole in the end of the pinion and fitting in a slot in the end of the cylinder. The top of the cylinder is held in place by a pin passing through a support from the main pillar, and a hole in the end of the cylinder.

To the large upright pillar is fastened a U-tube, about $\frac{1}{2}$ an inch diameter, one end being nearly as high as the pillar and the other but half the height. The tube is filled with mercury to within about an inch of the top of the short arm. The stem of the plant is cut off near the base and placed in position. An inverted U-tube is fastened to the stem in the usual way by means of a rubber tube tied with wire while the other end of the U-tube is connected to the larger one in the same way. The small U-tube is filled with water through an opening in the top.

The cylinder is made of bright tin and is blackened by revolving it slowly in the flame of a lamp or gas jet.

The indicator consists of a light steel wire with a cork at the end somewhat smaller than the diameter of the tube. This rests on the mercury. It is then at the top of the tube bent at right angles twice and allowed to extend to the bottom of the cylinder, where it is again bent at right angles and the end allowed to rest against the smoked surface of the cylinder. A pin driven in the pillar prevents the wire from turning to one side because of the friction of its end with the cylinder.

As the root absorbs water the pressure upon the column of mercury increases, causing it to rise in the tube, lifting the cork and indicator with it. The indicator then marks a continuous spiral course on the cylinder. As the cylinder revolves once each hour the hourly variation can be studied by observing the distance between the lines.

The supply of water given to the plant is kept constant by means of a flask of water supported by a stand and having an exit tube touching the surface of the water in the dish in which is placed the jar containing the plant.

The apparatus can be made in sizes appropriate for the study of periodicity of root pressure in almost any plant.

An eight day clock should be used and the apparatus need scarcely be touched until the plant is exhausted. The difference between the maximum and minimum variation will grow less as the column of mercury becomes higher but the time of variations will be the same for each day.

The apparatus described may be constructed at a very small expense and used either for laboratory experiments or lecture room demonstration. Many new and interesting problems have arisen during the investigations with this instrument and it is hoped they can be arranged for presentation in the near future.

The record on the cylinder of the apparatus shown in plate XV was made by a tomato plant. The experiment was started at 9 A. M., that being the time represented by the bottom line on the cylinder. The apparatus is represented otherwise as at the beginning of an experiment.

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On the apical growth of the stem and the development of the sporangium of Botrychium Virginianum.

C. L. HOLTZMAN.

(WITH PLATE XVI.)

The origin and affinities of the Filicineæ is one of the most important problems of systematic botany. Among investigations directed to solving this problem not least have been those concerning the origin of the Filices and the relations of the eusporangiate and leptosporangiate groups. It has been advocated by some that the Ophioglosseæ form a natural se-